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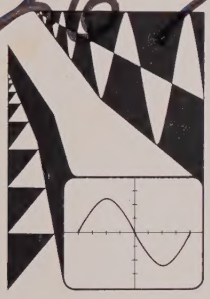

Portable 50MHz storage multiplier oscilloscope

PM3243

9499 440 16011

760915/1/01

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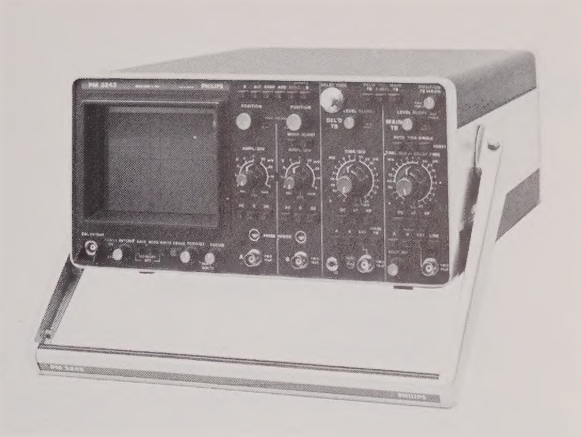

Operating manual

Portable 50MHz storage multiplier oscilloscope

PM3243

This insert must be used
with the manual of the
basic PM 3240 oscilloscope

Order number of
this insert 9499 440 16011

760915/1/01

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1.General information

1.1. INTRODUCTION

The PM 3243 Portable 50 MHz Storage Multiplier Oscilloscope enables the measurement, storage and multiplying of signals at a high sensitivity (5 mV/DIV).

A wide choice of display modes is available, such as single channel operation, two channels alternately or chopped, two channels added, with normal and inverted position for one input signal, two channels multiplied, and a main and delayed time-base.

The PM 3243 oscilloscope features a tapless power supply with low dissipation.
The power supply operates satisfactorily from any a.c. mains voltage between 90 V and 264 V, or any d.c. voltage between 100 V and 200 V, thus obviating the need for adjusting the instrument to the local mains voltage.

All these features combine to make the PM 3243 oscilloscope suitable for a wide variety of applications.

Features

Summarising, the PM 3243 oscilloscope is characterised by the following features:
- 5 mV sensitivity at 50 MHz.
- Built-in 40 MHz multiplier.
- Simultaneous display of the product and one of the factors.
- Variable persistance and storage.
- Advanced design.
- Highly efficient power supply unit, operating from a wide range of a.c. or d.c. voltage supplies without voltage switching.

Note: The design of this instrument is subject to continuous development and improvement. Consequently, this instrument may incorporate minor changes in detail from the information contained in this manual.

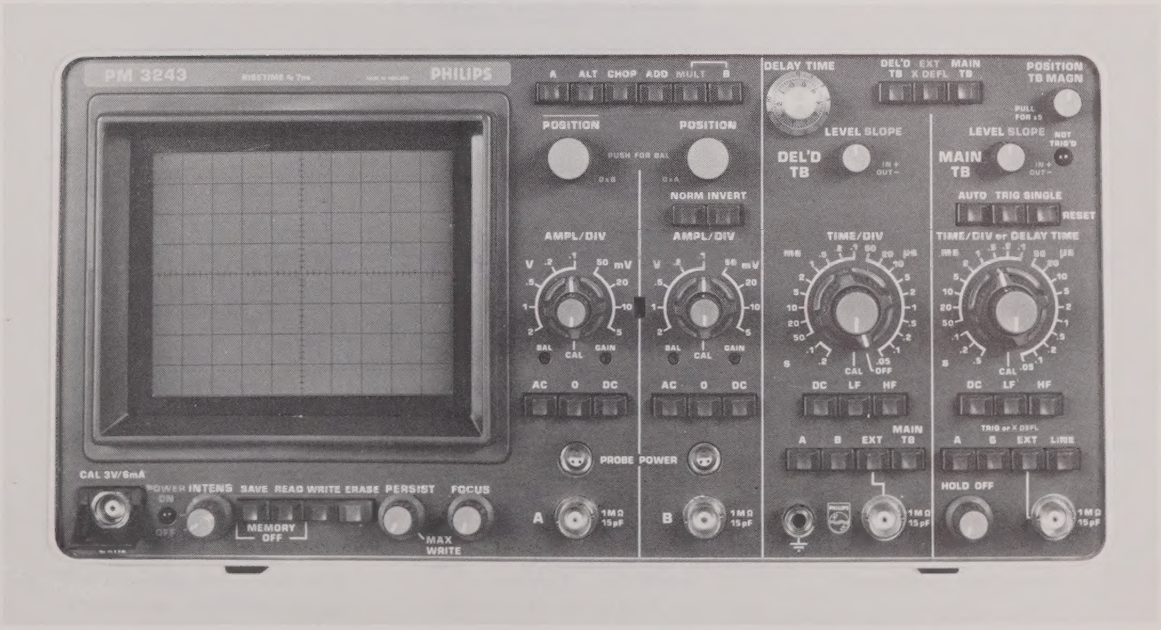

Fig. 1.1. PM 3243

1.2. CHARACTERISTICS

This instrument has been designed and tested in accordance with IEC Publication 348 for Class 1 instruments and has been supplied in a safe condition. The present Instruction Manual contains information and warnings, which shall be followed by the purchaser to ensure safe operation and to retain the instrument in a safe condition.

This specification is valid after the instrument has warmed up for 30 minutes.

Properties expressed in numerical values with tolerances stated, are guaranteed by the manufacturer. Numerical values without tolerances are typical and represent the characteristics of an average instrument.

Designation	*Specification*	*Additional information*
C.R.T.		
Type	L14-110GH/55	Rectangular, post-accelerator half-tone storage tube
Useful screen area	8 x 10 div.	1 division = 0,9 cm
Screen type	P31 phosphor	
Total acceleration voltage	8,5 kV	
Graticule	Internal	
Persistence		
Normal	Natural persistence of P31 phosphor	(10 μs ... 1 ms)
Variable	Continuously variable from 0,3 sec. to 1,5 min.	
Storage time		
In 'write' mode (max. persist.)	1,5 min.	
In 'read' mode	3 min.	
In 'save' mode	15 min.	
Writing speed		
Normal	0,2 div./μs	
Max. write	2 div./μs	
Erase	Pushbutton operated, erasure takes 600 ms (approx.)	
Vertical or Y Axis		
Number of channels	2	
Display modes	Channel A only Channel B only A and B chopped A and B alternated A and B added A x B multiplied A x B and B, chopped The polarity of channel B can be inverted	
Display time per channel in	Approx. 500 ns	
Bandwidth	d.c. .... 50 MHz	d.c. coupled Upper bandwidth limit –3 dB
	10 Hz ... 50 MHz	a.c. coupled –3 dB bandwidth limit
Risetime	7 ns	
Deflection coefficients	5 mV/div ... 2 V/div	Nine calibrated positions in 1-2-5-sequence. Uncalibrated, continuous control between the steps 1:2,5

Designation	*Specification*	*Additional information*
Accuracy	± 3 %	
Max. permissible input voltage	± 400 V	d.c. + a.c. peak
Input impedance	1 MOhm//15 pF	
Coupling	AC-0-DC	
Input RC time	22 ms	AC coupling
Maximum deflection	Undistorted deflection of 24 div. for sine-wave signals with frequencies of up to 15 MHz	
Shift range	16 div.	
Signal delay	20 ns	
Common-mode rejection factor	100:1 at 1 MHz	
Multiplier		
Bandwidth	d.c. ... 40 MHz (–3 dB)	
Risetime	9 ns	
Multiplication factor	1 ± 0,02	The product of signal A with A cm and signal B with B cm is displayed with A x B cm ± 2 %
Dynamic range		
Signal A	8 cm	+ or – 4 cm from centre of screen
Signal B	8 cm	+ or – 4 cm from centre of screen
Product A x B	8 cm	+ or – 4 cm from centre of screen
Signal delay	8 ns	Between product and signal B.
Product offset	0,2 cm at 23 deg. C	
Display modes	A x + or – B A x + or – B and + or – B, chopped	
Multiplier output	BNC socket at rear of instrument, d.c. coupled: Output voltage: 50 mV/div. into 50 Ohm 100 mV/div. into 10 kOhm Bandwidth: d.c. ... 40 MHz -3 dB upper bandwidth limit	

Horizontal or X Axis

Horizontal deflection can be obtained either from the Main time base or from the Delayed time base, a combination of the two, or from the signal source selected for X-deflection. In the last-mentioned case, X-Y diagrams can be displayed using ch. A or B, the EXT. connector or the line (mains) as a signal source for horizontal deflection.

Display modes	Main time base	
	Main time base intensified by delayed time base	
	Delayed time base	
	X-Y operation	by Y_A, Y_B, External or Line (mains)

Horizontal amplifier

Bandwidth	d.c. ... 1 MHz over 6 div. –3 dB upper limit	
Deflection coefficient	450 mV/div. using EXT connector Vertical attenuator coefficients apply when Y_A or Y_B is used for X deflection	

Designation	*Specification*	*Additional information*
Input impedance	1 MOhm//15 pF	
Measuring accuracy	± 10 % using Y_A or Y_B input	
Phase error	3° at 100 kHz	
Main time base		
Modes	Auto - triggered - single shot	
Time coefficients	0,5 s/div ... 50 ns/div in 1-2-5 sequence. Uncalibrated continuous control between seps 1:2,5 x5 magnifier extends max. sweep rate to 10 ns/div.	
Variable hold-off	Sweep hold-off time can be increased by at least a factor of 5.	
Accuracy	± 3 % (additional error of ± 2 % for magnifier)	
Delayed time base		
The delayed time base either starts immediately after delay time or can be triggered after delay time by the selected time base trigger source.		
Time coefficients	0,2 s/div ... 50 ns/div in 1-2-5 sequence. Uncalibrated control between steps 1:2.5. x 5 magnifier extends max. sweep rate to 10 ns/div.	
Accuracy	± 3 % (additional error of ± 2 % for magnifier)	
Sweep delay	In steps, variable with main time base. Continuously variable by 10-turn potentiometer between 0,2x and 10x the time coefficient of the main time base.	
Delay time jitter	1:20.000	
Incremental delay time error	0,5 %	
Delayed gate output	Rear panel connector providing logic "1" TTL output pulse during main time base intensified and delayed time base running times. For Multiplier applications.	
Main time base triggering		
Trigger source	Internal ch. A or B External Line (mains)	
Slope	+ or –	
Trigger coupling	Auto : 10 Hz ... 50 MHz DC : d.c. ... 50 MHz LF : d.c. ... 50 MHz HF : 50 kHz ... 50 MHz	
Sensitivity	Internal External	
Level range	Internal 24 div. typical External –5 to +5 V typical	
Ext. input impedance	1 MOhm//15 pF	Identical to Y-input
Delayed time base triggering		
Trigger source	Internal, ch. A or B External Other trigger specifications of the delayed time base are identical to those of the main time base.	

Designation	*Specification*	*Additional information*
Amplitude calibrator		
Voltage	+3 V	Square wave, base-line zero volts
Current	6 mA	Square wave, through current loop
Accuracy	± 1 %	For both voltage and current
Frequency	2 kHz ± 2 %	
Protection	The output is short-circuit-proof	
Power		
Line voltages	Accepts any voltage between 100 V and 240 V ± 10 % at any frequency between 46 and 440 Hz in one range, without switching.	
DC power service	Accepts any d.c. voltage between 100 V and 200 V	
Power consumption	39 W	
Probe power	Two sockets providing +24 V and −24 V for active probes. Current drain max. 2x50 mA for each output.	

Environmental capabilities

Note: The environmental data are valid only if the instrument is checked in accordance with the authorised checking procedure. Details on those procedures and failure criteria are supplied on request by the PHILIPS organisation in your country, or by N.V. PHILIPS GLOEILAMPENFABRIEKEN, TEST AND MEASURING DEPARTMENT, EINDHOVEN, HOLLAND.

Ambient temperature	+5 deg. C ... +40 deg. C rated range of use −10 deg. C ... +55 deg. C operating −40 deg. C ... +70 deg. C storage and transit
Altitude	To 5.000 m operating To 15.000 m not operating
Humidity	Meets IEC 68 Db requirements
Bump tests	1000 bumps of 10 g, ½ sine, for 6 ms duration in each of three directions.
Vibration	30 min. in each of three directions, 10 Hz ... 150 Hz, 0,7 mm_{p-p} and 5 g max. acceleration
Electromagnetic intereference	Meets VDE, Störgrad K
Recovery time	Operates within 15 min. of being subjected to −10 deg. C, soak, then taken into room conditions of 60 % relative humidity at +20 deg.
Dimensions and weight	Height 154 mm Width 316 mm Depth 460 mm Weight 10,6 kg

Instrument options

The following options are available as service modifications.
Contact your local Philips field service engineer for details.
- Main time base sweep output
- Main time base gate output
- Delayed time base sweep output

Accessories

Supplied with the instrument

Contrast filter
Front cover
Collapsible viewing hood PM 9366
BNC banana adaptor PM 9051
Cal. terminal to BNC adaptor
Operating and service manual.

Some of above mentioned accessories are located inside the front cover.

Optional

PM 9335	Passive probe set 1:1 (1,5 m)
PM 9335L	Passive probe set 1:1 (2,5 m)
PM 9350	50 MHz passive probe set 10:1 (1,5 m)
PM 9350L	50 MHz passive probe set 10:1 (2,5 m)
PM 9358	150 MHz HV probe set 100:1
PM 9347	Active TV triggering probe
PM 9352	Micro miniature probe
PM 9353	Active FET probe 150 MHz
PM 9355	Current probe
PM 8910	Polaroid anti-glare filter
PM 9380	Oscilloscope camera
PM 8971	Camera adaptor
M3 ... M5	Steinheil Oscilloscope camera range
PM 8960	19" Rack mount adaptor
PM 8980	Long viewing hood
PM 8901	Rechargeable battery pack 140 V d.c.
PM 8991	Trolley
PM 8992	Accessory pouch

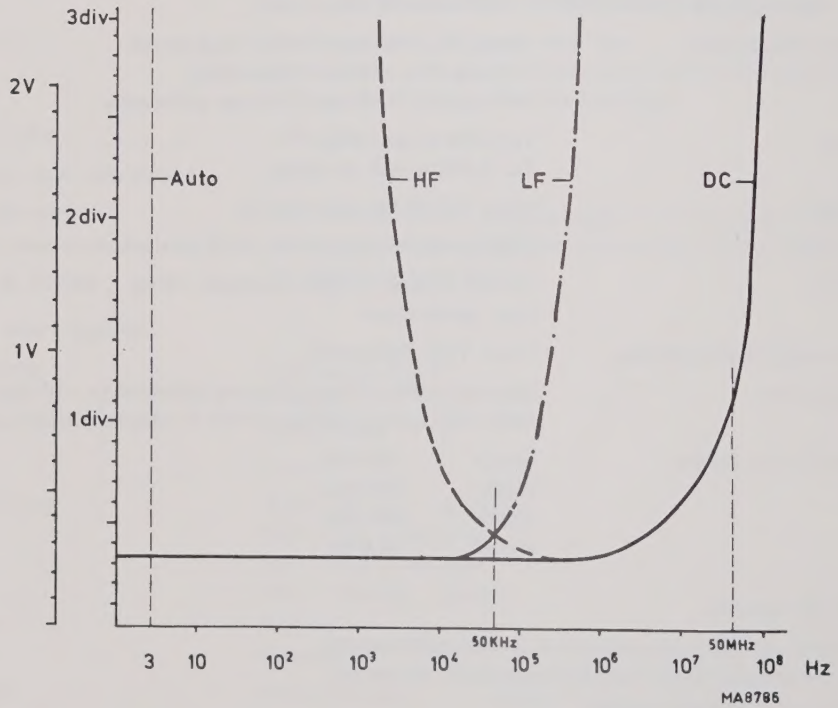

Fig. 1.2. Typical trigger sensitivity as a function of frequency

Fig. 2.1. Removing the front cover

Fig. 2.2. Opening the front cover

2. Direction for use

2.1. INSTALLATION

Front cover

Removing : — Turn the knob in the centre of the cover a quarter of a turn anti-clockwise to the UNLOCKED position.
— Lift off the cover.

Fitting : — Allgn the key of the front cover locking knob with the slot in the text plate of the instrument.
— Fit the cover over the front of the oscilloscope.
— Press and turn the locking knob a quarter of a turn clockwise to the LOCKED position.

The room in the front cover is available to accommodate accessories such as probes, collapsible viewing hood and so on.
To open the front cover press both tongues of the locking device and ligt the inner plate.

The **carrying handle** can be rotated by depressing the pushbuttons located on its pivots.

Warning: Before any connection is made to the instrument, the protective earth terminal shall be connected to a protective conductor (see section EARTHING).
This instrument generates high voltages and should not be operated with the cabinet covers removed.
The mains plug must be removed before attempting any maintenance work.

Line voltage and fuse

The ability of the instrument to operate at any line voltage between 90 V and 264 V a.c. or between 100 V and 200 V d.c. obviates the need of adaption to the local line voltage.
The 2 A, delayed action fuse, which is located on the rear panel, is suited for all line voltages. The use of repaired fuses and the short-circuiting of the fuse holder is dangerous and should be avoided.

Earthing

Before switching on, the instrument shall be connected to a protective earth conductor in one of the following ways:
Via the protective earth terminal at the rear (identified by the symbol ⏚) or via the three-core mains lead, provided that the supply socket is equipped with an earth connection.
The protective action must not be negated by the use of an extension cable without a protective conductor.

Warning: Any interruption of the protective conductor, either inside or outside the instrument, or disconnection of the protective earth terminal, is likely to make the instrument dangerous. Intentional interruption is prohibited. When an instrument is transferred from a cold to a warm environment condensation may cause a hazardous condition. Therefore, ensure that the earthing requirements are strictly observed.

Switching on

The POWER switch is incorporated in the front panel INTENS control, immediately below the screen bezel.

CAUTION

EXTENDED HIGH INTENSITY MAY DAMAGE THE CRT

In the "Variable Persistence" mode of operation, the CRT itself warns against too high an intensity by "blooming". When "blooming" occurs, intensity should be reduced by turning the INTENSity knob slightly anti-clockwise.
In the MEMORY OFF position and the X-Y mode of operation, no warning is indicated, therefore special care must be observed.

2.2. FUNCTION OF THE CONTROLS AND CONNECTORS

Vertical deflection

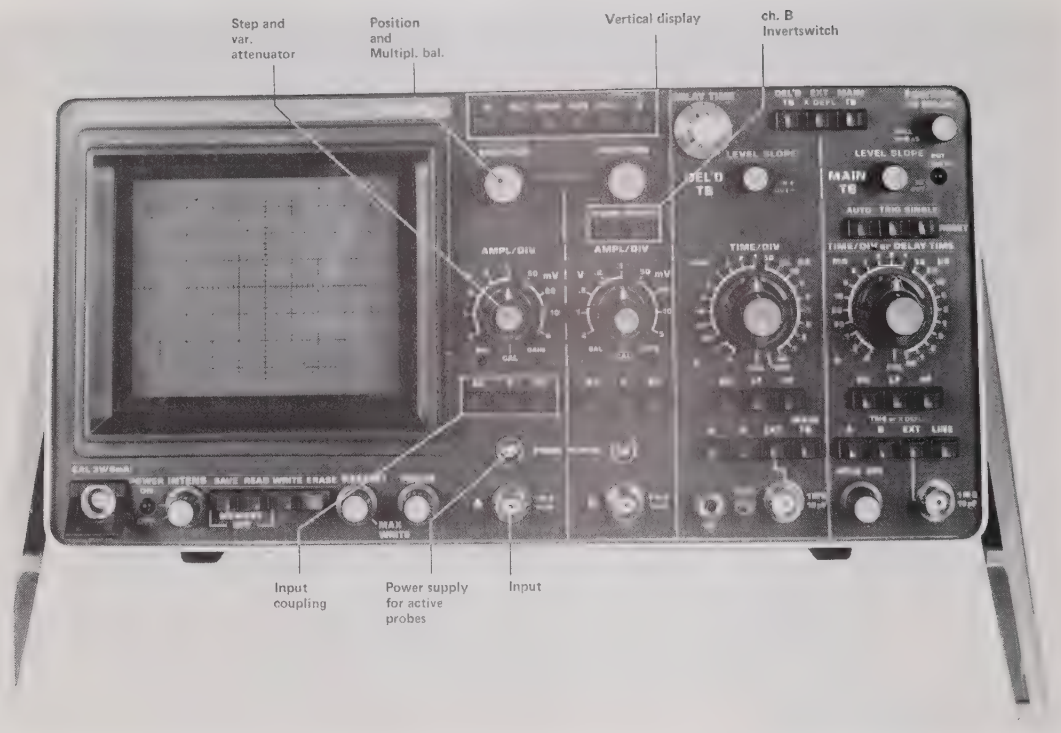

Fig. 2.3. Vertical deflection

Vertical display switch	Display-mode controls; 6-way pushbutton switch.
A depressed	Vertical deflection is achieved by the signal connected to the input of channel A.
ALT depressed	The display is switched over from one vertical channel to the other at the end of every cycle of the time-base.
CHOP depressed	The display is switched rapidly between one vertical channel and the other at a fixed frequency.
ADD depressed	Vertical deflection is achieved by the sum signal of channels A and B.
MULT depressed	Vertical deflection is achieved by the product signal of channels A and B.
B depressed	Vertical deflection is achieved by the signal connected to the input of channel B. If no pushbutton is depressed, the instrument operates in the A mode.
MULT + B depressed simultaneously	The display is switched between MULT and B (CHOP mode).
POSITION and MULTIPL. BAL. (o x A or B)	Continuous variable control giving vertical shift of the display. PUSH FOR BALANCE facility for Multiplier balance (off-set compensations).
NORM/INVERT	2-way pushbutton switch for the inversion of the B signal polarity. Neither pushbutton depressed has the same effect as the NORM button depressed.
AMPL/DIV	Step control of the vertical deflection coefficients; 9-way switch.
AMPL/CAL	Continuously variable control of the vertical deflection coefficients. In the CAL position the deflection coefficient is calibrated.

BAL (screwdriver operated)	Pre-set control of the direct voltage balance of the vertical amplifiers.
GAIN (screwdriver operated)	Pre-set control of the gain-calibration of the vertical channels.
AC/0/DC	Signal coupling; 3-way pushbutton switch.
AC depressed	Coupling via a blocking capacitor.
0 depressed	Connection between input circuit and input socket is interrupted and the amplifier input is earthed.
DC depressed	Direct coupling. No button depressed has the same effect as the AC button depressed.
A 1 MOhm - 15 pF	BNC input socket for channel A.
B 1 MOhm - 15 pF	BNC input socket for channel B.

Horizontal deflection

Fig. 2.4. Horizontal deflection

Horizontale display mode	Horizontal deflection controls; 4-way pushbutton switch.
MAIN TB depressed	The horizontal deflection voltage is supplied by the main time-base generator. A part of the trace is intensified (except in position OFF of the TIME/DIV switch of the delayed time-base generator). No button depressed has the same effect as the MAIN TB button depressed.
EXT. X DEFL depressed	Horizontal deflection is achieved by an external signal applied to the input socket of the horizontal amplifier, by the channel A signal, by the channel B signal, an external signal or by a mains frequency signal.
DEL'D TB depressed	The horizontal deflection voltage is supplied by the delayed time-base generator.
TRIG or EXT X DEFL	If the instrument is used in the timebase mode, the main time-base can be triggered by: A — Signal taken internally from channel A B — Signal taken internally from channel B EXT — Signal applied to the trigger input LINE — Line voltage (mains) internally connected
POSITION TB MAGN	Continuously variable control giving horizontal shift of the display; incorporates a push-pull switch which increases the horizontal deflection coefficient by a factor of 5. The magnifier is inoperative if an external X deflection signal is used.

Main time-base

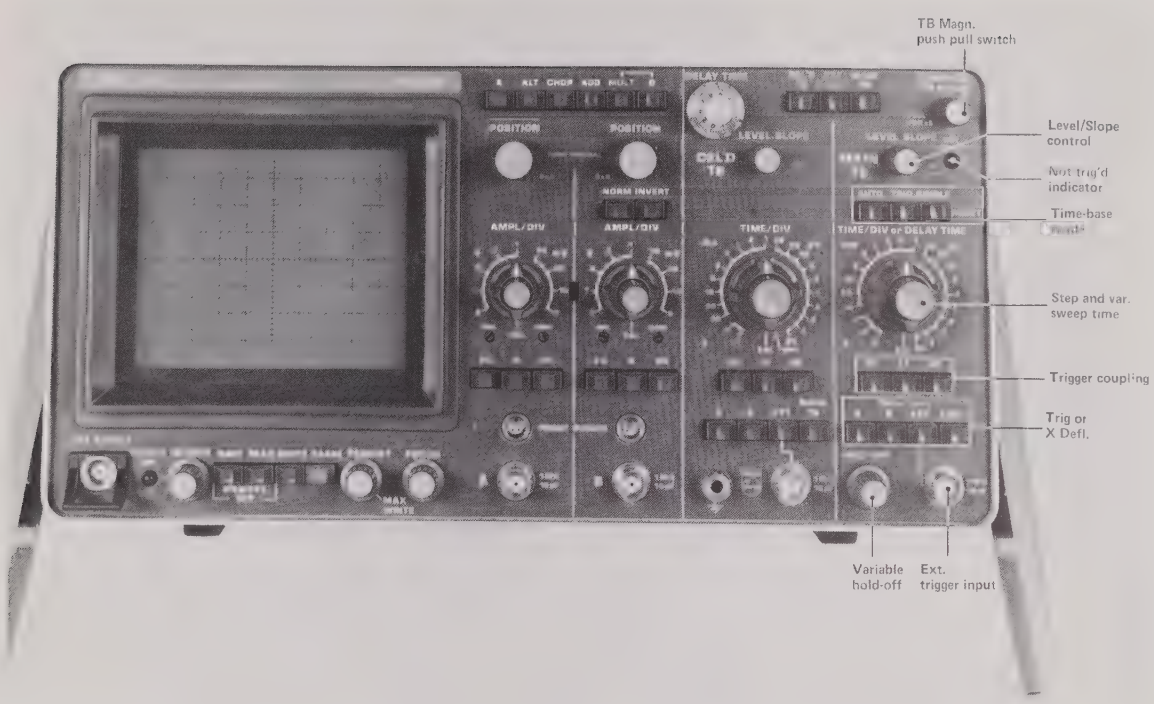

Fig. 2.5. Main time-base

LEVEL SLOPE	Continuously variable control to select the level of the triggering signal at which the time-base starts. This control incorporates a push-pull switch which enables choice of triggering either on the positive or negative-going edge of the triggering signal.
NOT TRIG'D	Pilot light that lights up when the time-base is not triggered; i.e. in the waiting position.
AUTO/TRIG/SINGLE	Trigger-mode controls; 3-way pushbutton switch.
AUTO depressed	The main time-base generator is free-running in the absence of triggering signals.
TRIG depressed	The time-base is normally triggered.
SINGLE depressed	After operating the SINGLE button, the time-base generator runs only once upon receipt of a trigger pulse. If no button is depressed, the instrument operates in the SINGLE mode. If no display is obtained when the instrument is switched on, and an input signal has been connected, check that the AUTO or TRIG modes have been selected for the main time-base.
TIME/DIV or DELAY TIME	Time-coefficient control of the main time-base; 23-way rotary switch.
TIME/DIV CAL	Continuously variable control of the time coefficient of the main time-base. In the CAL position the time coefficient is calibrated.
DC/LF/HF	Trigger coupling; 3-way pushbutton switch.
DC depressed	Triggering signals are direct coupled.

LF depressed	Coupling via low-pass filter for frequencies up to 50 kHz (for external triggering via band-pass filter of 10 Hz to 50 kHz).
HF depressed	Coupling via a high-pass filter for frequencies higher than 50 kHz. No pushbuttons depressed has the same effect as button DC depressed.
TRIG or X DEFL	Trigger source or external X deflection selector; 4-way pushbutton.
A depressed	Internal triggering or X deflection signal derived from channel A.
B depressed	Internal triggering or X deflection signal derived from channel B.
EXT depressed	Triggering on external-signal connected to the adjacent 1 MOhm-15 pF socket. When the EXT X DEFL button of the horizontal deflection controls is depressed, this socket is connected to the input of the horizontal amplifier.
LINE depressed	Triggering or X deflection signal derived from an internal voltage at mains frequency.
1 MOhm - 15 pF	BNC socket for external triggering or horizontal deflection.

Delayed time-base

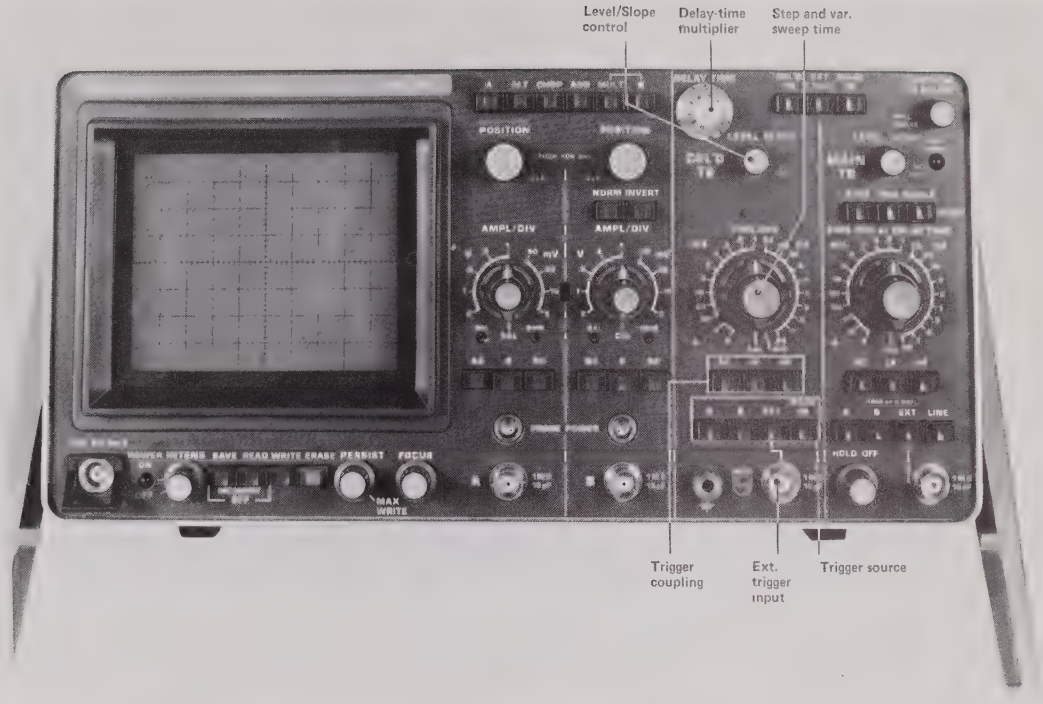

Fig. 2.6. Delayed time-base

DELAY TIME	Calibrated continuously variable control of the delay time, operating in conjunction with the TIME/DIV controls of the main time-base generator.
LEVEL SLOPE	Continuously variable control to select the level of the triggering signal at which the delayed time-base generator starts. This control incorporates a push-pull switch which enables choice of triggering on the positive or negative-going slope of the triggering signal.
TIME/DIV	Time-coefficient control of the delayed time-base; 22-way rotary switch. Incorporates OFF position in which the delayed time-base generator is switched off.
TIME/DIV CAL	Continuously variable control of the time coefficient of the delayed time-base generator. In the CAL position the time coefficient is calibrated.
DC/LF/HF	Trigger coupling; 3-way pushbutton switch.
DC depressed	Trigger signals are direct-coupled.
LF depressed	Coupling via low-pass filter for frequencies up to 50 kHz (for external triggering via band-pass filter of 10 Hz to 50 kHz).
HF depressed	Coupling via a high-pass filter for frequencies higher than 50 kHz. No button depressed has the same effect as the DC button depressed.
A/B/EXT/MAIN TB	Trigger source and starting point of the delayed time-base; 4-way pushbutton switch.
A depressed	Triggerable, after delay time, on channel A signal.
B depressed	Triggerable, after delay time, on channel B signal.
EXT depressed	Triggerable, after delay time, on an external signal connected to the adjacent 1 MOhm - 15 pF socket.
MAIN TB depressed	Delayed time-base starts immediately after delay time.
1 MOhm - 15 pF	BNC input socket for external triggering signal.

CRT Section

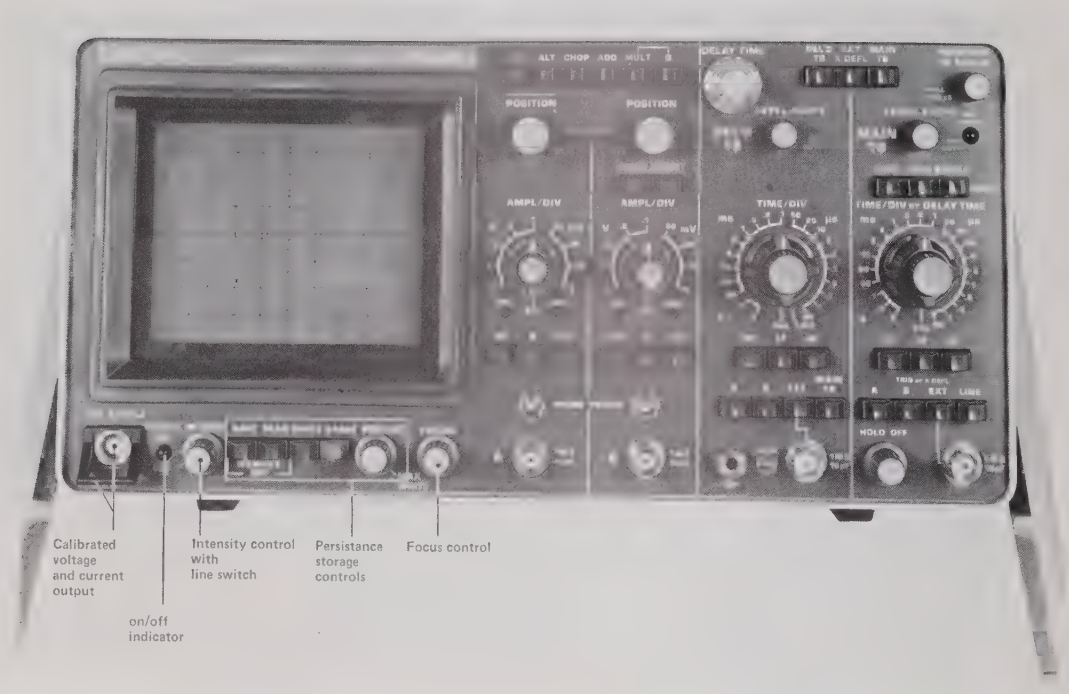

Fig. 2.7. CRT Section

CAL	Output socket on which a 3 $V_{p\text{-}p}$ square wave voltage to calibrate AMPL. control, and frequency response of voltage divider probes. Current loop with 6 $mA_{p\text{-}p}$ current for calibration of current probes.
POWER ON/OFF	Pilot lamp indicates the ON state of the instrument.
INTENS	Continuously variable control of the display-brightness, combined with power on-off switch.
FOCUS	Continuously variable control of the electron beam focusing.
Storage/Persistence controls	
SAVE/READ/WRITE/ERASE	Waveform storage facility; 4-way pushbutton switch.
SAVE	Enables recorded waveform to be stored for a longer viewing time (protected against accidental erasure).
READ	Enables recorded waveform to be observed (protected against accidental erasure).
MEMORY OFF (SAVE + READ)	Allows operation of the instrument as an ordinary oscilloscope.
WRITE	Enables waveform to be recorded; in this mode PERSISTENCE control is operative.
ERASE	Enables erasure of the display in the WRITE mode. If the time base is in the SINGLE sweep mode this switch also resets the time base.

Rear panel

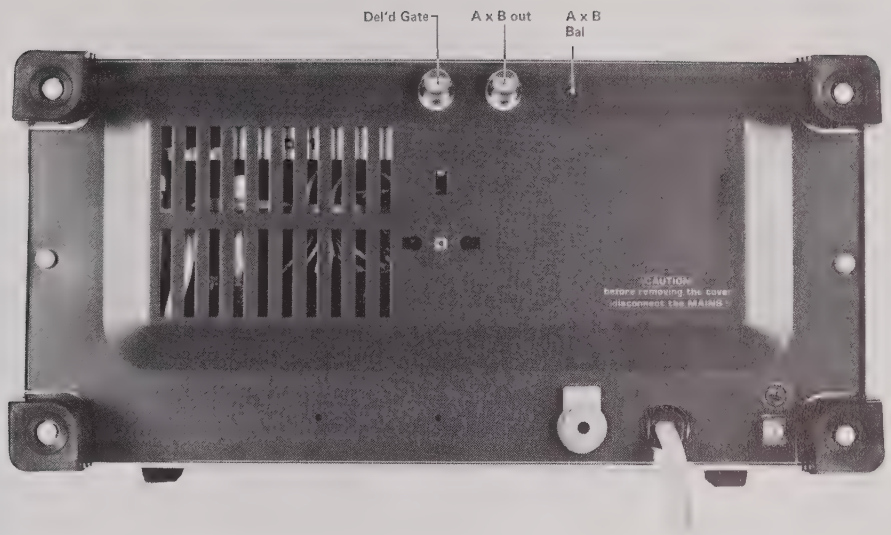

Fig. 2.8. Rear panel.

DEL'D GATE	Delayed time base gate output; TTL compatible. Logic "1" during main time base intensified and delayed time base running times. For Multiplier application.
A x B OUT	D.C. coupled non-integrated multiplier output.
A x B BAL	Multiplier output balance off-set compensation.
FUSE	2 A delayed action for all line.
Line cord with plug. Safety earth terminal.	

2.3. PRELIMINARY SETTINGS

Before measurements with this instrument are carried out, checking and adjusting of the following functions may be necessary:

- Step attenuator balance
- Gain calibration
- Multiplier balance (0 x A, 0 x B)
- Multiplier output balance

As the first two settings are identical for both vertical channels, only the procedure for channel A has been indicated.

1. Step attenuator balance

- Depress the MAIN TB button of the horizontal deflection mode switch.
- Depress the AUTO button of the main time-base mode switch.
- Set the INTENSITY and FOCUS controls for a sharp, well-defined trace.
- Depress the relevant channel button of the vertical deflection mode switch.
- Depress the 0 button of the input coupling switch.
- Set the POSITION knob so that the trace is somewhere about in the centre of the screen.
- Set the AMPL. continuous control to position CAL.
- Check that the trace does not jump when the AMPL. switch knob is rotated.
  If necessary adjust the BAL control.

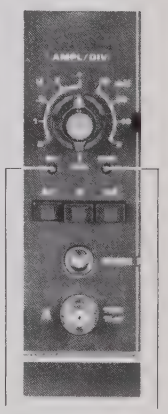

Fig. 2.9.

2. Gain calibration

Unless otherwise stated, the controls occupy the same positions as in the previous procedure.

- Set the AC-0-DC switch to AC.
- Set the AMPL. switch knob to .5 V and the continuous control to CAL.
- Connect the channel input to the CAL output.
- Check the vertical deflection is exactly 6 divisions.
  If necessary adjust the GAIN control.
- Also an attenuator probe can be included in this calibration.
  The probe attenuation factor must then be taken into account with respect to the AMPL. switch position.

3. Multiplier balance 0 x A, 0 x B

When either A or B is multiplied by 0 (zero), the product must be zero. Offset voltages at the multiplier inputs may still cause some deflection on the screen; these offset voltages must be reduced to a minimum by the following procedure:

Remark: The 0 x A and 0 x B controls are operated by pushing the POSITION knobs.

- Allow a warm-up time of at least 15 min, preferably 30 min.
- Apply an a.c. signal with an amplitude within the specified dynamic range to both input A and input B.
- Depress pushbutton MULT of the display-mode controls.
- Depress pushbutton 0 of the channel A signal coupling controls.
- Depress pushbutton AC of the channel B signal coupling controls.
- Minimize the deflection by means of the 0 x B potentiometer without changing the attenuator setting.
- Depress pushbutton AC of the channel A signal coupling controls.
- Depress pushbutton 0 of the channel B signal coupling controls.
- Minimize the deflection by means of the 0 x A potentiometer without changing the attenuator setting.

4. A x B output balance

When using the A x B output at the rear panel, the output must be zero if both inputs are zero.
This can be compensated by the A x B BAL control located near this output.
Proceed as follows:

- check the 0 x A and 0 x B adjustment as indicated under point 3.
- Depress both 0 switches of the ch. A and B inputs.
- Adjust the A x B BAL control unless the A x B output voltage is zero.

2.4. OPERATING INSTRUCTIONS

General

Before switching-on, ensure that the oscilloscope has been correctly installed in accordance to the INSTALLATION recommendations (Chapter 2.1.) and the precautions outlined have been observed.
To use the instrument as an ordinary oscilloscope; i.e. without the storage facility, depress the SAVE and READ pushbuttons simultaneously (MEMORY OFF).

Inputs A and B and their possibilities

The oscilloscope has been provided with two identical channels, each of which can be used for either YT measurements in combination with one or both time-base generators, or XY measurements in combination with the external horizontal channel.

YT measurements

To display one signal, either of the two vertical channels can be selected by operating either pushbutton A or pushbutton B of the display-mode controls.
When pushbutton ALT or CHOP is depressed, two different signals can be displayed simultaneously. The Y deflection coefficient and the polarity can be selected for each channel individually. When the ALT button is depressed, the display is switched over from one channel to the other at the flyback of the time-base signal. Although the ALTERNATE mode can be used at all sweep speeds of the time-base generator, the CHOPPED mode will give a better display quality for long sweep times, because during these long sweep times the alternate display of the two input signals would be clearly visible to the eye.
In the CHOPPED mode, the display is switched over from one channel to the other at a fixed frequency.
If pushbutton ADDed of the display-mode switch is depressed, the signal voltages of both vertical channels are added. Depending on the position of the channel B polarity switch, either the sum or the difference of the input signals is displayed.

XY measurements

If pushbutton EXT X DEFL of the horizontal deflection control is operated, the time-base generators are switched off. A signal applied to the A channel is then used for horizontal deflection, if button A of the TRIG or X DEFL switch is operated.
The AC/0/DC switch and the step attenuator of channel A remain operative.
Continuous control of the deflection coefficients is possible with the continuous control AMPL and horizontal trace shift with the X POSITION control.
Vertical channel B may also be used for X deflection. In this event, the B button of the TRIG or X DEFL controls is depressed.
It is also possible to use an internal voltage at the line frequency or a signal applied to the EXT socket at the bottom right-hand side of the front panel for X deflection, after pressing the relevant pushbutton of the TRIG or X DEFL controls.

AC/0/DC switch

The signals under observation are fed to input sockets A and/or B, the AC/0/DC switch being set to either AC or DC depending on the composition of the signal. As the vertical amplifier is d.c. coupled, the full bandwidth of the instrument is available and d.c. components are displayed as trace shifts in the DC position of the AC/0/DC switch.
This may be inconvenient when small signals superimposed on high d.c. voltages must be displayed. Any attenuation of the signal will also result in attenuation of the small a.c. component. The remedy is to use the AC position of input switch, which employs a blocking capacitor, to suppress the d.c. component. Some pulse drop, however, will occur when LF square-wave signals are displayed.
The 0 position interrupts the signal and earths the amplifier input for a rapid check on the 0 V level.

Using the Multiplier

The signals to be multiplied must be applied to input sockets A and B.

Dynamic range

Both multiplicants A and B must be within the dynamic range of the multiplier and preamplifier circuits. As an overload condition for these circuits may not be noticed in the displayed product, care must be taken to keep each of the input signals within the specified dynamic range, allowing for a maximum amplitude of 8 $div_{p\text{-}p}$.

For the displayed product again a maximum of 8 $div_{p\text{-}p}$ is specified. If the output maximum is exceeded, one of the input signals must be reduced in amplitude.

Multiplier output level

The multiplier output signal is displayed via the A channel. The displayed product with normally have a d.c. component. Therefore, it is important to know the zero level of the displayed product. The d.c. zero line can be shifted to the most convenient place on the screen by means of the channel A POSITION control if the 0 pushbutton of the signal-coupling control has been depressed.

Using the persistance/storage facility

Starting from the MEMORY OFF position (SAVE and READ pushbuttons simultaneously depressed), with the INTENSity and FOCUS controls set for a sharply-defined trace, the PERSISTENCE/STORAGE mode of operation can be obtained by depressing the pushbutton, WRITE.

The functions of the other controls are then as follows:

PERSIST	Depending on the position of the PERSISTence potentiometer, a rapidly vanishing trace will be written on a green background (knob completely anti-clockwise) or a slowly vanishing trace on a black background (knob on its first clockwise stop). The persistence can be set to suppress any flickering when displaying a low-frequency signal. For a signal with a low repetition rate and a short rise-time, the persistence can be set to fill-up the trace to obtain a clear, steady display.
SAVE	If a particular display needs to be retained, is can be saved by depressing the SAVE button. The display is then just visible.
READ	The intensity of the stored display increases by depressing the READ button, but brightness is achieved at the expense of storage time.
ERASE	When de display is no longer needed it can be erased by depressing the ERASE button. Any persistence of the trace, especially those parts written with substantial brightness, can be removed by prolonged operation of the ERASE button.
MAX WRITE	The writing speed can be increased by a factor of 10 (approx.) by rotating the PERSISTence control to its second clockwise stop (MAX WRITE), so that the incorporated switch is operated. The MAX WRITE mode of operation is required for short sweep times or for signals with a short rise-time.

Triggering

If a signal must be displayed, the horizontal deflection must always be started on one fixed point of the signal to obtain a stationary display. The time-base generator is, therefore, started by narrow trigger pulses formed in the trigger unit and controlled by a signal originating from one of the vertical input signals, an internal voltage at mains frequency or an external source.

Trigger coupling

Three different trigger-coupling methods can be chosen with the DC/LF/HF switch. In the HF and LF positions, the transfer characteristic is limited.
In position DC the trigger signal is passed unchanged. In position LF, a d.c. (10 Hz for external triggering) to 50 kHz band-pass filter is inserted. This position can be used to reduce interference from noise. In position HF, a 50 kHz high-pass filter is inserted. This position can be used to reduce intereference from e.g. hum.

Selecting the trigger source and setting the trigger level

The trigger signal is obtained from channel A (button A depressed), channel B (button B depressed), an external source (button EXT depressed) or from an internal voltage at mains frequency (button LINE depressed).
The trigger pulse shaper is a multivibrator switched by the output signal of the trigger amplifier.
The trigger signal, which is affected by the continuous AMPLitude control is, together with direct voltages which are adjustable with the LEVEL potentiometer, fed to the input of the trigger amplifier.
Depending on the LEVEL setting, a certain part of the trigger signal will be amplified by this amplifier.
The multivibrator is thus switched at a fixed point of the trigger signal.
This means that, with the aid of the LEVEL control, it is possible to scan the shape of the trigger signal (in case of internal triggering A or B equal to the shape of the signal to be displayed) and, thus, to choose the point where the multivibrator will be switched.
The LEVEL potentiometer is fitted with a push-pull switch which allows selection of the trigger slope.

Automatic triggering

When the AUTOmatic button of the AUTO/TRIG/SINGLE switch is depressed, and if there are no trigger pulses available, the time-base generator is automatically free-running.
The trace is, therefore, always visible. The AUTOmatic mode can be used in all cases where the TRIG mode is also usable, except with signal frequencies lower than 10 Hz or pulse trains with an off time exceeding 100 ms. As soon as trigger pulses are available, the free-running state of the time-base generator is automatically terminated and the time-base generator is triggered again.
When the TRIGgered or SINGLE button is depressed, the auto-circuit is switched off.
The LEVEL setting can also be used in the AUTOmatic mode.

SINGLE sweep triggering

When effects that occur only once have to be observed (usually photographed), it is desirable to ensure that only one sawtooth is generated, even though several trigger pulses might be produced after the phenomenon of interest. Naturally, the single sawtooth in question must be triggered by a trigger pulse, therefore, the SINGLE button must be pressed. The first trigger pulse that appears after the button has been released will start the time-base generator.
The time-base generator is then blocked until the SINGLE pushbutton is again depressed.
The NOT TRIG'D lamp will light up as soon as the SINGLE button has been released, until a further trigger pulse arrives.
Note that also the ERASE button resets the time base in the single sweep mode.

Time-base MAGNifier

The time-base magnifier is operated by a push-pull switch incorporated in the horizontal POSITION control. If this switch is pulled to position x5, the sweep speeds of the main time-base generator are increased by a factor of 5. Thus the portion of the signal displayed over a width equal to two divisions in the centre of the screen in the x1 position (TB MAGN depressed), will occupy the full width of the screen in the x5 position. Any portion of the trace can be brought on to the screen by the horizontal POSITION control for observation. In the x5 position, the time coefficient is determined by dividing the indicated TIME/DIV value by 5.

Use of the delayed time-base

If the MAIN TB button of the horizontal display switched is depressed, and the delayed time-base TIME/DIV knob is not in the OFF position, part of the main time-base sweep line is displayed at higher intensity.
In this way, part of the displayed signal can be selected for more detailed observation. The selected part of the signal is displayed over the whole screen by pressing the DEL'D TB switch.
The sweep time of the intensified part of the main-time-base sweep depends on the delayed time-base TIME/DIV knob.
With the centre knob, sweep times between the steps can be adjusted. For time measurements this knob must always be in the CAL position.

The starting time of the delayed time-base is determined by the settings of the main time-base TIME/DIV or DELAY TIME 10-turn multiplier knob.

If the MAIN TB trigger selector switch of the delayed time-base is pressed, the delay time after which the delayed time-base is started, is the product of the main time-base TIME/DIV switch setting and the DELAY TIME multiplier knob.

If instead of MAIN TB, the delayed time-base is triggered by A, B or EXT, the delayed time-base will start after this delay-time and upon receipt of a trigger pulse. This trigger pulse is supplied by the trigger unit of the delayed time-base generator. This position is used when time jitter would otherwise give a blurred image of the detail under observation. This time jitter could be part of the signal being investigated or, at extreme

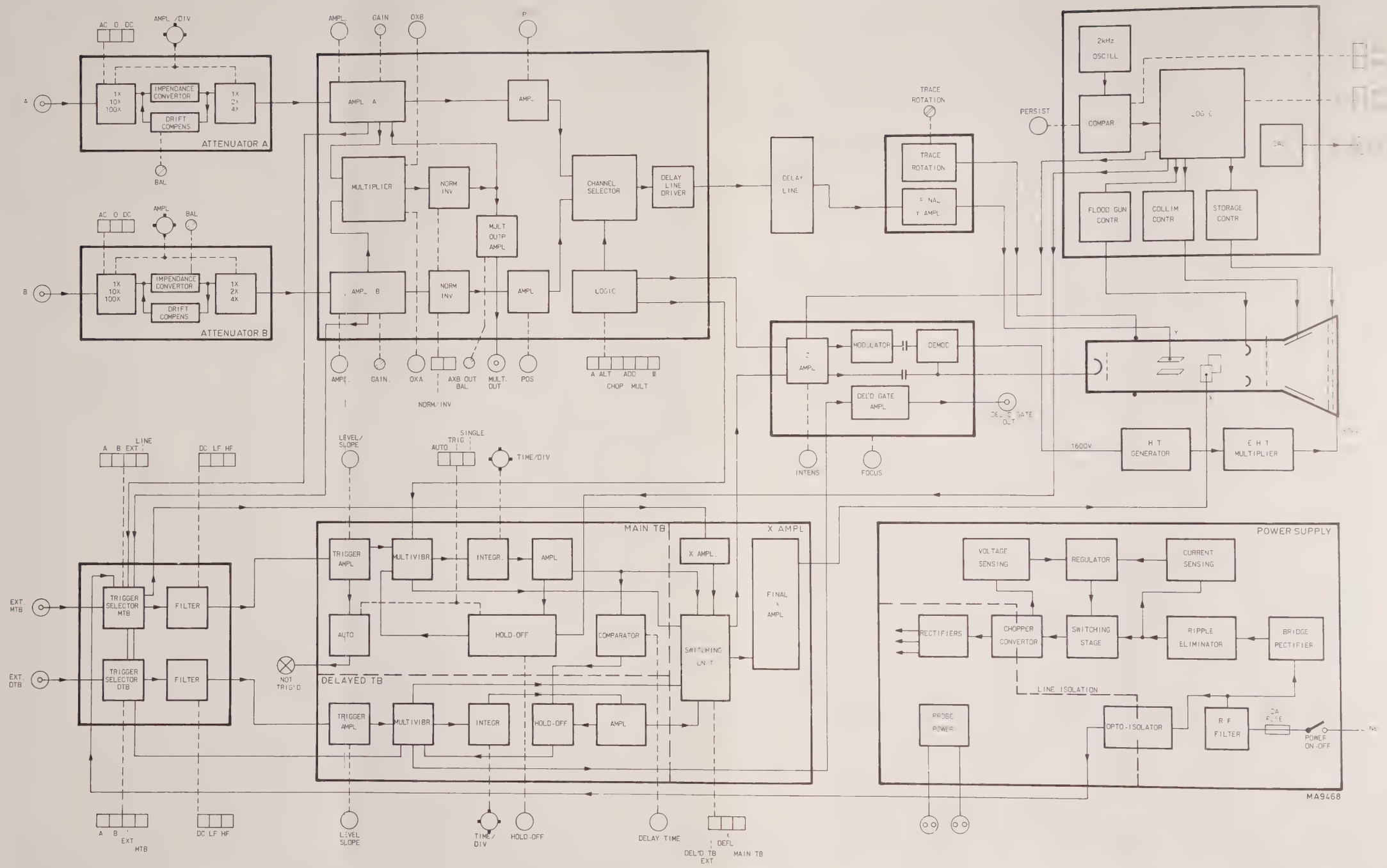

Fig. 2.10 Block diagram

2.3. DESCRIPTION OF THE BLOCK DIAGRAM

Refer to Fig. 2.10

General information

The PM 3243 oscilloscope comprises the following parts:

- a dual-channel vertical deflection system with signal multiplication facility
- a main time-base
- a delayed time-base
- a switching unit
- an X amplifier
- a Z modulator and c.r.t. circuit with persistence storage facilities
- e.h.t. supplies
- a power supply

Dual-channel vertical deflection system

The A and B vertical channels are almost identical circuits. The main differences are that channel B has a switch facility for signal inversion, and in the multiplier mode the signal is routed via the A channel after multiplication.
The input signal to each channel is fed via a three-position coupling switch AC/0/DC to the input attenuator. In the AC position a capacitor is switched in series with the signal path. In the 0 position the input signal path is interrupted and the attenuator input is earthed.
The input attenuator, controlled by the AMPL/DIV switch via reed relays, enables the adjustment of the vertical deflection sensitivity in calibrated steps. This attenuator consists of a high and low impedance part separated by an impedance converter, with a drift-compensation circuit.
The d.c. balance of the entire channel is set by a BAL potentiometer which compensates for the d.c. offset voltage of the impedance converter.
The output signal of the attenuator is applied via a 50 Ohm coaxial cable to the intermediate amplifier where it is transformed into push-pull signal.
The intermediate amplifier provides the following functions:

- a signal for the trigger pre-amplifier
- GAIN calibration and BAL compensation controls
- shift for the Y trace by means of the POSITION control combined with 0 x A and 0 x B compensation controls
- electronic switching of the selected channel modes
- phase inversion of the B channel by means of the INVERT pushbutton.

The channel selector enables or inhibits the Y signals as dictated by the channel selection logic. In the A, B, ADD and MULT modes, the channel selector logic setting depends on the vertical display mode switch. In the ALT mode the channel selector logic is controlled by pulses derived from the sweep-gating multivibrator of the main time-base generator. In this way, the complete signal trace of channel A and channel B are alternately displayed on the c.r.t. screen.

In the CHOP mode, the channel selector control pulses are derived from an oscillator running at a fixed frequency of approximately 1 MHz. These pulses successively open and close the electronic switch in the channel selector so that portions of the signals of channel A and channel B are alternately and repetitively displayed.

In the MULT mode, the signals to be multiplied are taken out of the amplifier stages of channels A and B and are multiplied in the multiplier circuit. The resulting signal is amplified and re-inserted in the amplifier of channel A. If MULT and B pushbutton are simultaneously depressed, both signals are displayed in the CHOP mode.

A common output for the A and B channels feeds the delay line, which delays the vertical signals sufficiently to permit the steep leading edges of fast signals to be displayed. A delay-line correction circuit compensates for the distortion introduced by the delay line. A final stage feeds the Y signals to the vertical deflection plates of the c.r.t.

Time-bases

Main time-base

The trigger source/X deflection selector receives its signal from one of four sources:

- either A or B vertical channels via its trigger amplifier
- from the EXT input socket
- from the opto-isolator in the power supply.

Selection of these sources is by means of the four-pushbutton unit in this stage.

From the selector stage, the signal is fed to either the X pre-amplifier for horizontal deflection (when external X signal is employed), or the trigger amplifier for starting the time-base generator. The input of the trigger differential amplifier stage contains the control for selecting the input frequency range of the trigger circuit. The trigger LEVEL adjustment and SLOPE selection switch are also incorporated in this stage. The SLOPE selector switches the differential amplifier to invert the polarity of the trigger signal to enable triggering of the input signals on either positive or negative-going slopes.
The output of the trigger amplifier is applied to the trigger multivibrator, which produces well-defined trigger pulses. These trigger pulses are used to switch the sweep-gating multivibrator and, when the AUTO pushbutton has been selected, for driving the auto-circuit.

The sweep-gating multivibrator controls the starting and stopping of the integrator circuit that produces the sawtooth waveform required for the horizontal deflection.
The integrator circuit consists of charging capacitors switched by transistors, and the resistors selected by the TIME/DIV switch to set the time coefficients in calibrated steps. Continuous control of these time coefficients is obtained by varying the charging current of the time-determining capacitors by means of the TIME/DIV potentiometer.
The resulting sawtooth signal of the integrator is fed to the X deflection selector, the hold-off multivibrator and the comparator, which is part of the delayed time-base unit.
The hold-off multivibrator resets the sweep-gating multivibrator and inhibits its input during the flyback period of the sawtooth waveform. The hold-off circuit also incorporates the single sweep circuit that causes the main time-base to produce a single sawtooth waveform after the SINGLE pushbutton has been depressed and on receipt of a trigger pulse.

The automatic free-run circuit or auto-circuit makes the time-base free-running when no trigger pulses are applied.

Delayed time-base

If the MAIN TB of the horizontal display switched is depressed, and the delayed time-base TIME/DIV knob is not in the OFF position, part of the main time-base sweep line is displayed at higher intensity.
In this way, part of the displayed signal can be selected for more detailed observation. The selected part of the signal is displayed over the whole screeen by pressing the DELD'D TB switch.
The sweep time of the intensified part of the main time-base sweep depends on the delayed time-base TIME/DIV knob.
With the centre knob, sweep times between the steps can be adjusted. For time measurements this knob must always be in the CAL position.

The starting time of the delayed time-base is determined by the settings of the main time-base TIME/DIV OR DELAY TIME knob and the DELAY TIME 10-turn multiplier knob.

If the MAIN TB trigger selector switch of the delayed time-base is pressed, the delay time after which the delayed time-base is started, is the product of the main time-base TIME/DIV switch setting and the DELAY TIME multiplier knob.

If instead of MAIN TB, the delayed time-base is triggered by A, B or EXT , the delayed time-base will start after this delay-time and upon receipt of a trigger pulse.

In principle, the delayed trigger-unit and time-base generator use similar circuits to those of the main trigger-unit and time-base generator. The delayed time-base always operates in the single-shot mode. The sweep is initiated by the main time-base generator which also serves as hold-off for the delayed time-base.

The DELAY TIME control in conjunction with the comparator and reset multivibrator determine the delay time for the delayed time-base generator. The delayed time-base is operative unless its TIME/DIV control is in the OFF position. It starts immediately after the delay time, or upon receipt of the first trigger pulse after the delay time. It can be triggered by the A, or B channels, or externally.
When pushbutton MAIN TB of the horizontal deflection mode controls is depressed, the part of the trace coinciding with the delayed sweep is intensified.

Switching unit and X amplifier

The X deflection selector couples the external X deflection signal from the X (pre)amplifier, the output of the main time-base generator or the output of the delayed time-base generator to the X amplifier, which feeds the horizontal deflection plates. The X amplifier comprises the horizontal trace positioning and the x5 magnification controls.

The blanking pulse selector supplies blanking pulses to the Z amplifier. These pulses blank the trace at the end of the main time-base sweep and provide the extra bright-up pulse if the oscilloscope operates with a portion of the trace intensified. The blanking pulses during the switching of the traces in the chopped mode go direct from the channel selector logic to the Z amplifier.

CRT circuits and Z amplifier

The c.r.t. circuits include stages for trace blanking and unblanking, an automatic brightness control unit, circuits appertaining to the storage functions of the c.r.t. and networks for the correction of the c.r.t. characteristics.
The automatic brightness control (a.b.c.) unit ensures a virtually constant trace brilliance or a blanked trace in various display modes.
In the continuous display mode, the trace is blanked and unblanked by a signal from the main time-base generator.
In the single-sweep mode, the trace is blanked via the a.b.c. unit.
The trace storage circuits provide the voltage levels and waveforms which are necessary for the storage operation of the c.r.t., under the control of the SAVE, READ, ERASE and WRITE pushbuttons.
The correction networks comprise preset potentiometers for trace rotation, astigmatism, flood gun filament potentials, distortion.
The high-voltage for the post-acceleration anode of the c.r.t. is supplied by a stabilized h.t. generator , the output of which is rectified and multiplied by a factor of 5.

The Z amplifier receives two input signals. One originates in the time-base generator and is applied, via the switching circuit, to the Z amplifier to blank the trace during flyback; the other is supplied by the channel selector logic to blank the trace during switching in the chop mode.

The INTENS potentiometer determines the amount of input current fed to the Z amplifier.
At the output of the amplifier, the signal is split into two parts: an l.f. + d.c. part and an h.f. part. The h.f. part is fed direct to the Wehnelt cylinder of the c.r.t. An oscillator signal is modulated by the l.f. + d.c. part and the composite signal is afterwards detected in a peak-to-peak detector. Both signals are combined again on the Wehnelt cylinder.
The focus control also forms part of the c.r.t. circuit.
The calibrator, an integral part of the oscilloscope, is a square-wave generator which supplies an accurate voltage and current for calibration purposes.

Stabilized power supply

The mains voltage is full-wave rectified and fed to a voltage regulator. The voltage regulator contains a current sensor which controls in such a way that the output voltages of the power supply stay within specified limits.
The rectified mains voltage controls a blocking oscillator which generates a voltage at a frequency of approximately 20 kHz. This voltage is applied to the primary winding of a transformer. The secondary voltages of this transformer are full-wave rectified, smoothed and applied to the various circuits.

The LINE (MAINS) triggering signal is taken direct from the mains and, via an opto-isolator, fed to the trigger circuits at a safe level, completely isolated from the mains.

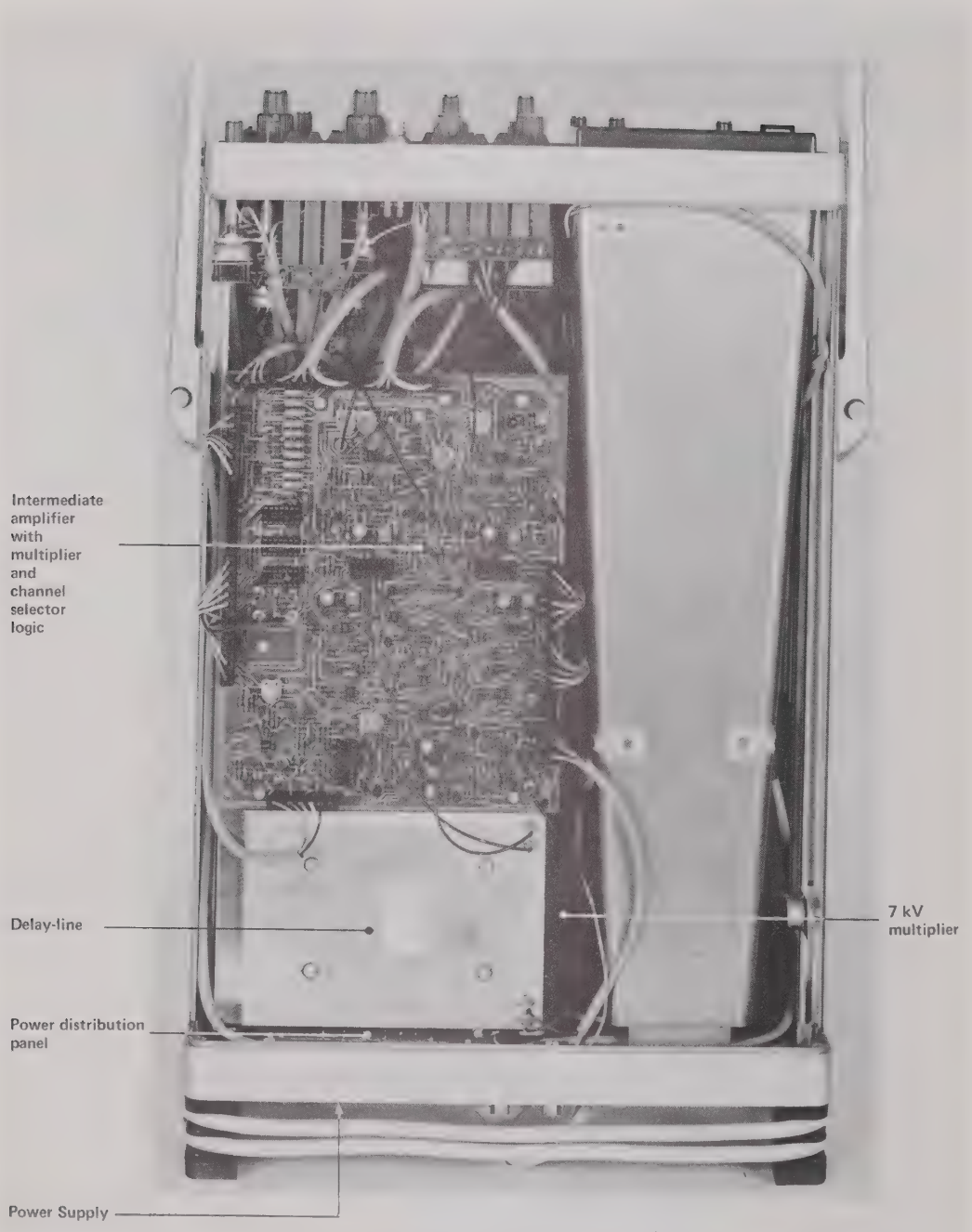

Fig. 3.1. Unit location, top view

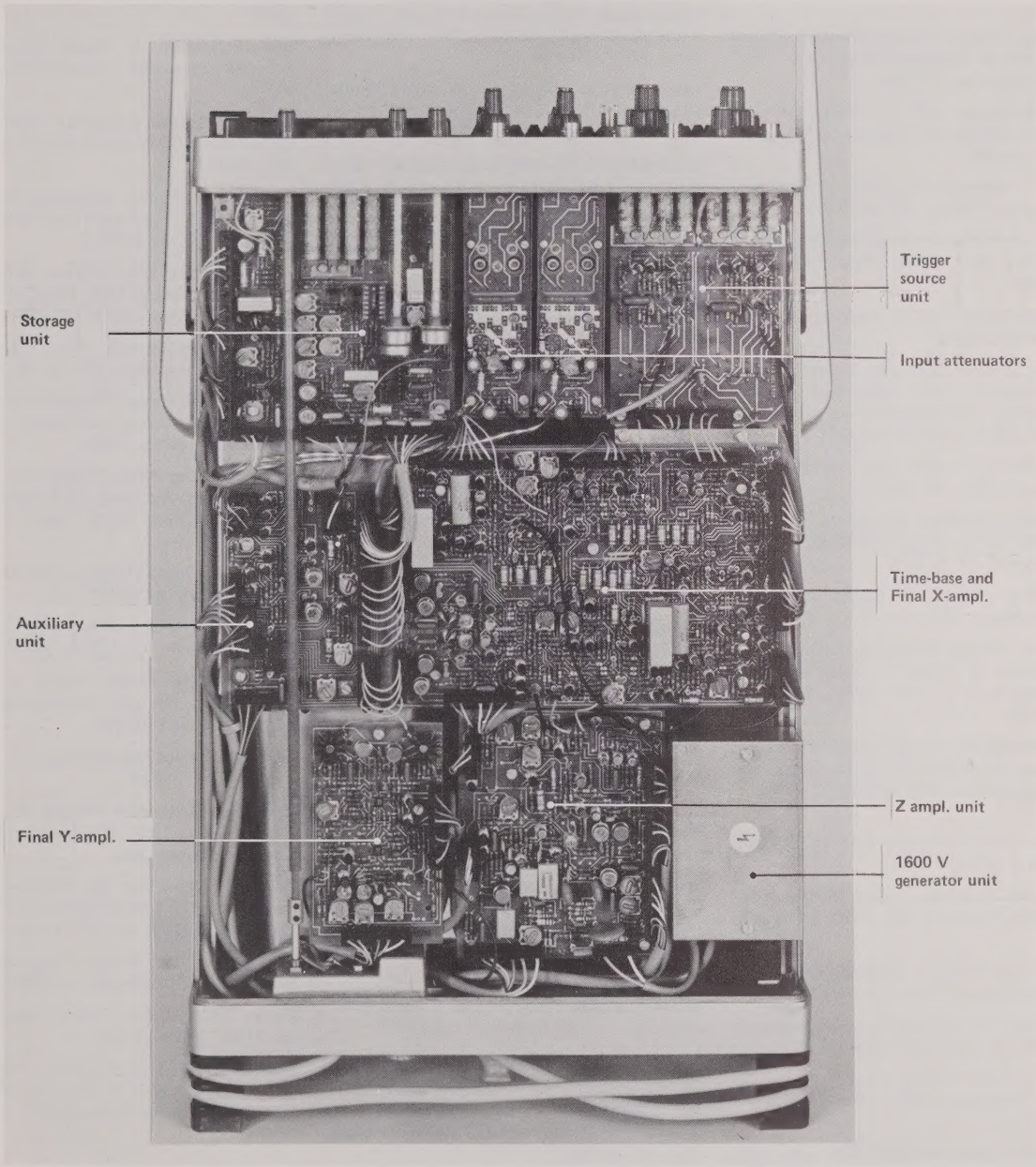

Fig. 3.2. Unit location, bottom view

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